

REMARKS

Claims 1-14 remain in the application. The claims have been carefully reviewed and amended with particular attention to the points raised in the Office Action. It is submitted that no new matter has been added and no new issues have been raised by the present amendment.

A substitute specification, a copy of the specification showing changes made, and an abstract on a separate sheet are submitted herewith as required by the Office Action, in the appendix attached following page 13 of this paper.

Reconsideration is respectfully requested of the rejection of claim 3 under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite. The instance noted in the Office Action has been addressed by the amendments made to the claims hereby.

Withdrawal of the rejection of claim 3 under 35 U.S.C. § 112, second paragraph, is respectfully requested.

Reconsideration is respectfully requested of the rejection of claim 1 under 35 U.S.C. § 102(e), as allegedly being anticipated by U.S. Patent No. 5,740,361 to Brown.

Applicants have carefully considered the comments of the Office Action and the cited reference, and respectfully submit that claim 1 is patentably distinct over the cited reference for at least the following reasons.

The present invention relates to a method and apparatus for mutual authentication of components in a network using a challenge-response method. At least one data pair including a first random number and a first response are requested from an

authentication center. The first random number is passed to a terminal which uses an internally stored key and the first random number to calculate the first response.

The calculated first response is sent to the network, and a second random number is sent from the terminal to the network. A second response calculated in the authentication center is sent in response to the second random number. The first response sent from the terminal to the network is also used as the second random number, and the network has previously requested the second response from the authorization center together with the first random number and the first response as a triplet data set.

Brown, as understood by Applicants, relates to a system and method for authenticating users and services communicating over an insecure network. Each user and service has a pass-phrase used for authentication. The pass-phrases are not revealed during the authentication process as challenge-response techniques are used to keep the pass-phrase secret. Pass-phrases are known by an authentication entity with which the service communicates to authenticate both users and services. Users may have identities and services may support a number of realms, each of which may include a large collection of users. Users choose realms within which they are authenticated. The system and method may be adapted for use with the HyperText Transfer Protocol of the World Wide Web for secure transactions between users and services communicating via the Internet.

The Office Action states that Brown discloses a method

for mutual authentication of components in a network wherein, inter alia, a first response sent from the terminal to the network is also used as a second random number (see Office Action, p. 4, ln. 23 to p. 5, ln. 13). Applicants respectfully disagree.

As understood by Applicants, Brown discloses the use of pass-phrases to allow a service to authenticate a user and to allow the user to authenticate the service over an insecure network (see Brown, col. 4, lns. 30-58). An authentication "deity" is used to store the pass-phrases of the users and services, and the service may either communicate with the "deity" during the authentication process or act as its own "deity" if it knows the pass-phrases (see id.).

The authentication mechanism of Brown, as understood by Applicants, includes authentication, reauthentication, and reauthentication cheating processes (see id., col. 4, ln. 66 to col. 5, ln. 14). The authentication process allows for a user and a service to mutually authenticate one another within one of a set of realms without revealing their respective pass-phrases (see id.). The reauthentication process allows for another authentication without requiring communication with a third party or authentication "deity" (see id.).

As understood by Applicants, the reauthentication process of Brown is essentially an ordinary challenge-response mechanism in which a secret 128-bit session key is used as a pass-phrase (see id., col. 9, ln. 65 to col. 10, ln. 25). In the reauthentication process the service first sends a challenge (Cs) to the user, and the user sends a challenge

(Cu) to the service (see id.). The user calculates a response (Ru) to the challenge and sends it to the service, which verifies the result (see id.). If correct, the service calculates a response (Rs) and sends it to the user, which verifies it (see id.).

In contrast, in the present invention, a first response (Response 1), calculated in the terminal and sent from the terminal to the network, is used as the second random number (Challenge 2). The network is not required to send another random number to the terminal. The required random number (Challenge 2) is available in the terminal, as it corresponds to the first response (Response 1) which has been calculated by the terminal (see specification of the present application, p. 4, lns. 11-19).

That is, in the present invention, the terminal does not produce the second random number (Challenge 2) internally, but equates it to the second response (Response 2) (see id., p. 4, ln. 20 to p. 4a, ln. 5). The network can thus produce a second response and send it to the terminal, which compares it to the value in the terminal to determine if the network is authentic (see id.).

It is respectfully submitted that Brown does not disclose or suggest a method for mutual authentication of components in a network comprising the steps of requesting at least one data pair including a first random number (Challenge 1) and a first response (Response 1) from an authentication center, passing the first random number to the terminal which uses an internally stored key to calculate the first response, sending

the calculated first response to the network sending a second random number (Challenge 2) from the terminal to the network, and responding to the second random number with a second response (Response 2) calculated in the authentication center, wherein the first response sent from the terminal to the network is also used as the second random number, whereby the network has previously requested the second response from the authorization center together with the first random number and the first response, as described above and as recited in amended independent claim 1.

Furthermore, it is respectfully submitted that Brown does not disclose or suggest a request from the authorization center of a triplet data set including the second response, the first random number, and the first response, before the performance of the authorization procedure, as recited in amended independent claim 1.

Accordingly, for at least the above-stated reasons, it is respectfully submitted that independent claim 1, and the claims depending therefrom, are patentable over the cited reference.

Withdrawal of the rejection of claim 1 under 35 U.S.C. § 102(e) is respectfully requested.

Reconsideration is respectfully requested of the rejection of claims 2-14 under 35 U.S.C. § 103(a), as allegedly being unpatentable over Brown in view of U.S. Patent No. 5,544,245 to Tsubakiyama.

Applicants have carefully considered the comments of the Office Action and the cited reference, and respectfully submit

that claims 2-14 are patentably distinct over the cited reference for at least the following reasons.

Tsubakiyama, as understood by Applicants, relates to a mutual authentication/cipher key delivery system in which a communication network and all of its users have devices for implementing a common key cryptosystem. Identifier  $ID_i$  of user  $i$  is made public in the network. An authentication key  $K_i$  of user  $i$  is known only to the network and the user, and each user generates a random number  $r_n$  for authentication of the network and sends it and his identifier  $ID_i$  to the network.

The network inputs into a specific function  $F()$  the random number  $r_n$  received from the user and a random number  $r_u$  generated by the network itself, encrypts the resulting output value  $F(r_n, r_u)$  by an encryption algorithm  $ElK_i()$  using the authentication key  $K_i$  of the individual user as a cipher key and sends the encrypted data  $C_i$  to the user. The user obtains  $D_i$  by inputting the data  $C_i$  into inverse function  $ElK_i^{-1}()$  of the encryption algorithm  $ElK_i()$  using the user's authentication key  $K_i$  as a cipher key, inputs  $D_i$  into an inverse function  $F^{-1}()$  of the function  $F()$ , and judges the network to be valid only when  $d_i$  is equal to the random number  $r_n$ .

It is respectfully submitted, however, that neither Brown nor Tsubakiyama, alone or in combination, disclose or suggest a method for mutual authentication of components in a network comprising the steps of requesting at least one data pair including a first random number (Challenge 1) and a first response (Response 1) from an authentication center, passing the first random number to the terminal which uses an

internally stored key to calculate the first response, sending the calculated first response to the network sending a second random number (Challenge 2) from the terminal to the network, and responding to the second random number with a second response (Response 2) calculated in the authentication center, wherein the first response sent from the terminal to the network is also used as the second random number, whereby the network has previously requested the second response from the authorization center together with the first random number and the first response, as described above and as recited in amended independent claim 1.

Additionally, it is respectfully submitted that neither Brown nor Tsubakiyama, alone or in combination, disclose or suggest the request from the authorization center of a triplet data set including the second response, the first random number, and the first response, before the performance of the authorization procedure, as described above and as recited in amended independent claim 1.

Accordingly, for at least the above-stated reasons, it is respectfully submitted that independent claim 1, and the claims depending therefrom, including amended claims 2-14, are patentable over the cited references.

Withdrawal of the rejection of claims 2-14 under 35 U.S.C. § 103(a) is respectfully requested.

Should the Examiner disagree, it is respectfully requested that the Examiner specify where in the cited document there is a basis for such disagreement.

The Office is hereby authorized to charge any fees which

may be required in connection with this amendment and to credit any overpayment to Deposit Account No. 03-3125.

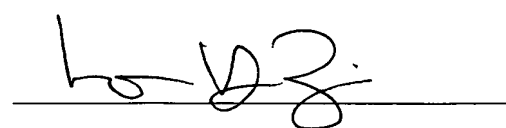
Favorable reconsideration is earnestly solicited.

Dated: January 6, 2004

I hereby certify that this paper is being deposited this date with the U.S. Postal Service as first class mail addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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**METHOD AND APPARATUS FOR MUTUAL AUTHENTICATION OF  
COMPONENTS IN A NETWORK USING THE CHALLENGE-RESPONSE  
METHOD**

~~The invention relates to a method and an apparatus for mutual authentication of components in a network using the challenge-response method, as claimed in the preamble of claim 1. In particular, the invention relates to mutual authentication of a terminal, preferably a mobile station, with the network, and vice versa. The following text uses the term "mobile station"; this should not be regarded as a limitation. This term is intended to cover all possible terminals, including stationary terminals, such as individual users of a computer in a wire-based system.~~

~~Authentication is used to check the authenticity of the component to be authenticated.~~

BACKGROUND OF THE INVENTION

The prior art ~~is~~ includes the so-called challenge-response method~~[[:]]~~ in . In this method, a random number (challenge) is sent by the authenticating component (N = network) to the component (M = mobile station) to be authenticated and is converted into a response using an

algorithm (A) and a secret key  $K$  ( $K$ ) which is known to both components. The expected response is calculated in the network N using the same key K and the same algorithm A; a match between the response sent back by M and the response calculated in N proves the authenticity of M.

Mutual authentication is achieved according to the prior art by the above sequence being carried out with the opposite role distribution.

Accordingly, in the known challenge-response method, the fixed network passes a challenge to the mobile station M, and the mobile station M answers with a response which has been calculated by using a computation method which is implemented in the mobile station and which includes a secret key K. This key K is unique. This means that only this mobile station can respond in the way expected of it, provided it is authenticated as being "authentic". No other mobile station (M) can simulate this key.

A disadvantage of the previous method is that the entire authentication method can be verified only and exclusively in the AUC (authentication center), that is to say, in practice, in the computation center.

Specifically, for security reasons, it has been found to be advantageous in system architectures to control A and K at a central point (in the authentication center = AUC), with the authenticating point N (which carries out

the authenticity check) having transmitted to it in advance only challenge/response pairs (possibly a number of them as a stockpile) for the purpose of authentication.

The challenge/response pairs transmitted from the AUC to the network (on request from the network in the form of a so-called "duplet request") are thus already to a large extent calculated in advance "as a stockpile" and, when the response arrives from the mobile station M during the authentication process, the two responses are compared. If they match, this thus ends the authentication method for the mobile station M with the network N.

The known methods from the prior art accordingly provide for the mobile stations to authenticate themselves with the network. This results in a risk of the network being simulated by unauthorized persons and thus of the relevant mobile station M being "spoofed by" the simulated network, with a mirror-image of the mobile station M being created in the process, but in this case for the "right" network N. In this unallowed situation, the M would authenticate itself with the simulated network N, thus allowing the unauthorized operator on the simulated network to call up non-public data from this mobile station M.

As one example, the GSM network should be mentioned which, at the moment, carries out only single-ended

authentication (M authenticates itself with N). The TETRA Standard which is also known allows double-ended authentication.

The method is explained in the following text in order to provide a better description of the terms ~~"Challenge 1, Response 1 and Challenge 2, Response 2"~~ "Challenge 1," "Response 1," "Challenge 2," and "Response 2" used ~~later~~ below:

The Challenge 1 is used to authenticate the mobile station M with the network N. As soon as this authentication has been successfully completed, the mobile station M requests reverse authentication, such that a check is now carried out as to whether the present network N is also really the authorized network and not a network being simulated in an unallowed manner. The aim is thus to authenticate the network N with the mobile station M. In this case, the mobile station M sends a Challenge 2 to the network, which passes the Challenge 2 on to the AUC where the Response 2 is calculated from it, and this is in turn sent to the network N, which passes the Response 2 to the mobile station. If the mobile station finds that the Response 2 which it has itself calculated matches the received Response 2, the authentication process is thus successfully ended. This authentication pair is referred to as Challenge 2/Response 2.

A disadvantage of mutual authentication in such system architectures is that the challenge sent by M cannot be converted into the response in N, but only in the AUC which, in some circumstances, leads to considerable time delays between the N-AUC-N data transfer and the on-line computation operation in the AUC.

#### SUMMARY OF THE INVENTION

The invention relates to a method and an apparatus for mutual authentication of components in a network using the challenge-response method. In particular, the invention relates to mutual authentication of a terminal, preferably a mobile station, with the network, and vice versa. Authentication is used to check the authenticity of the component to be authenticated.

The following text uses the term "mobile station," but this should not be regarded as a limitation. The term "mobile station" is intended to cover all possible terminals, including stationary terminals, such as individual users of a computer in a wire-based system.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows, schematically, an authentication method according to the prior art.

Fig. 2 shows a first embodiment for authentication according to the invention.

Fig. 3 shows a second embodiment for authentication according to the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

The invention is based on the object of improving the known method for authentication of components in a network, in particular in a GSM network, such that this method is considerably speeded up.

In order to achieve the stated object, the method is distinguished by the fact that the Response 1 sent back by the mobile station M is simultaneously used by the network N as the Challenge 2, and this has the advantage that the Response 2 (as the response to the Challenge 2) is also calculated and transmitted by the AUC at the same time as the abovementioned challenge/response pairs. This avoids the time delay which would occur if N had to supply the Response 2 only after the Challenge 2 had arrived at the AUC.

The invention thus provides that, in order to identify the authenticity of the network N, the mobile station no longer produces a Challenge 2 internally and sends it to the network but, by equating the Response 1 to the Challenge 2, a mutual match between M and N already exists via the expected Challenge 2. The network can thus produce a Response 2 at this stage and send it to the mobile station, which compares this Response 2 with the value it has itself calculated and, if they match, recognizes the network as being "authentic".

The important factor in this case is thus that the Response 1 sent from the mobile station to the network is at the same time used as the Challenge 2 from this mobile station, but which the mobile station no longer needs to send into the network, and waits for the Response 2 of the network.

Specifically, the network already knows the Challenge 2 from the mobile station, since the Response 2 has already been calculated internally. The network can thus calculate the Response 2 at this stage.

According to the invention, the mutual authentication of the mobile station with the network and, after this, the authentication of the network with the mobile station are no longer carried out immediately successively in time, with a relatively high time penalty, but the two

authentication tests are now interleaved with one another in time.

Complete data transmission of a test number (Challenge 2) is thus avoided since, according to the invention, the Challenge 2 can be saved and need no longer be transmitted. The separate transmission of the Response 2 by the network is saved due to the fact that the network sends the Response 2 to the mobile station at the same time that the Challenge 1 is sent. This is justified by the fact that the network already knows in advance what the Challenge 2 from the mobile station will be, that is to say the network can thus also send the Response 2 to the mobile station immediately. The network thus transmits the data pair Challenge 1/~~Response 1~~/Response 2 to the mobile station in a single data transmission. This means that the mobile station can identify the authenticity of N even before M has authenticated itself with N.

There are two different configurations in this case:

In a first embodiment, the network transmits the Challenge 1 to the mobile station. The mobile station M answers with the Response 1. Once a large number of triplet data packets (triplet = Challenge 1/~~Response 1~~/Response 2) have been transmitted in advance from the AUC to the network, the network N also knows the Response 1 of the mobile station M in advance. However,

since it knows the Response 1, it also knows the Challenge 2. The mobile station now no longer sends the Challenge 2 to the network, but the network answers the Response 1 from M with the Response 2. However, only the "real" network has this knowledge; a simulated, unallowed network does not have this knowledge; ~~the~~ . The network N has thus authenticated itself with the mobile station by the transmission of a single data packet (Challenge 1/ Response 2), saving the transmission of the second data packet (Challenge 2) .

In this case, it is advantageous that the Response 2 is a function of the Response 1. This means that the Response 2 can be calculated from the Response 1 = Challenge 2, provided the functional relationship is known. According to the prior art, the Response 2 was a function of the Challenge 2. According to the invention, the Challenge 2 need no longer be transmitted since Challenge 2 = Response 1 and is a function of Challenge 1.

In the end, making the Response 1 equivalent to the Challenge 2 means that the Response 2 is also a function of the Challenge 1.

Accordingly, in the first refinement, the Challenge 1 and the Response 2 are sent to the mobile station M immediately successively in time.

A second refinement provides for the Challenge 1 and Response 2 to be sent jointly to the mobile station M, as a data packet.

The mobile station answers this with the Response 1, and the network now compares the Response 1 with the expected value of Response 1, while the mobile station compares the Response 2 with the internally calculated value of the Response 2.

In known systems (for example in the GSM network), the length of the response (32 bits) is shorter than the challenge random number (128 bits). In order to allow the response to be used at the same time as a challenge for authentication of N with M using the same algorithm A, it is necessary to increase the length of Response 1 to the length of 128 bits expected by the algorithm A.

This could be achieved by quadruple concatenation of Response 1 ( $4 \times 32 \text{ bits} = 128 \text{ bits}$ ) or by filling out 128 bits in a previously defined manner (on a subscriber-specific basis or independently of the subscriber).

Proposals for the subscriber-specific filling-out process are:

1. Use of the complete computation result for the Response 1 before it has been shortened to 32 bits for transmission to the other station[[,]]\_.

2. Filling out with defined bits from the Ki which is known in the M and AUC.

The advantage of both embodiments over the prior art is thus that the data traffic between the network and the mobile station on the one hand, as well as the data traffic between the network and the AUC is simplified, and thus speeded up. According to the prior art, four messages have to be sent backward and forward between the network and the mobile station M, namely the Challenge 1, Response 1, Challenge 2 and Response 2.

Furthermore, the network must first transmit the Challenge 2 to the AUC, which must calculate the Response 2 and pass it to the network, and this is associated with a further time penalty.

According to the invention, time-consuming on-line interrogation from the network to the AUC is avoided. This is achieved in that the data packets required for this purpose from the AUC are called up even before the actual data traffic for authentication between the network and mobile station, and are buffer-stored for subsequent use in the network.

Such data packets (triplets) can be called up by the network from the AUC even well in advance (for example hours or days in advance). A common feature of both

configurations in this case is that the Response 1 is used as the Challenge 2, and it is thus possible to dispense with the actual transmission of the Challenge 2.

A number of preferred exemplary embodiments will now be described in more detail with reference to the drawings. In this case, further features of the invention will become evident from the drawing and its description. In the drawing:

~~Fig. 1 shows, schematically, an authentication method according to the prior art,~~

~~Fig. 2 shows a first embodiment for authentication according to the invention,~~

~~Fig. 3 shows a second embodiment for authentication according to the invention.~~

In the configuration shown in Fig. 1, the network N first of all requests data sets as duplet packets (duplet request) from the AUC.

These duplet packets contain data sets for the Challenge 1/ Response 1. As soon as a mobile station M now wishes to authenticate itself with the network N, N first of all sends the data set Challenge 1 to M, which answers with the Response 1. If N finds that the two data sets match, the "authenticity" of M with N is thus proven.

Conversely, M now requests the authenticity test of N by M sending to N a Challenge 2 which N passes on to the AUC where the required Response 2 is calculated from this, which the AUC passes to N, which in turn sends this to M. M now compares the internally calculated Response 2 and the Response 2 received from N, and recognizes the authenticity of N if the two match.

As has already been mentioned in the introduction, this convoluted data interchange places a severe load on the traffic between M and N on the one hand, and N and AUC on the other hand, and it is thus subject to time delays. This is where the first version of the new method as shown in Fig. 2 comes into play, which provides for N to request so-called triplet data sets in the form of Challenge 1/ Response 1/Response 1/Response 2 from the AUC. In this case, the data set Response 2 is a defined function of the data set Response 1, and can be calculated by means of an algorithm.

Such data sets are requested from the AUC a very long time before the handling of the data traffic from N with M and are stored in the form of multiple data sets in N. This avoids the necessity for on-line data traffic between N and the AUC, as was required for the prior art shown in Fig. 1. In order to authenticate M with N, N first of all sends the Challenge 1 to M, which M answers with the Response 1. Once N has identified the data set Challenge 2 which is sent from M to N in the prior art,

it is sufficient for N to send only the data set Response 2 to M for authentication with M. M has calculated the data set Response 2 internally and compares this with the Response 2 sent from N. If they match, the "authenticity" of N with M is thus proven.

In contrast to the method shown in Figure 2, the second embodiment of the method, shown in Figure 3, provides for N to send the data set Challenge 1/~~Response 1~~/Response 2 to M immediately and once. As soon as M sends back the data set Response 1, both authentication of M with N and, conversely, of N with M, are thus achieved.

# ABSTRACT

A method for mutual authentication of components in a network using a challenge-response method, including the steps of requesting at least one data pair including a first random number and a first response from an authentication center, passing the first random number to a terminal which uses an internally stored key and the first random number to calculate the first response, sending the calculated first response to the network, sending a second random number from the terminal to the network, and responding to the second random number with a second response calculated in the authentication center. The first response sent from the terminal to the network is also used as the second random number, and the network has previously requested the second response from the authorization center together with the first random number and the first response as a triplet data set.